National Institute of Environmental Health Sciences

Atmospheric impacts of the 2010 Russian wildfires: Integrating modelling and measurements of the extreme air pollution episode in the Moscow megacity region

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Abstract:

Numerous wildfires provoked by an unprecedented intensive heat wave caused continuous episodes of extreme air pollution in several Russian cities and densely pullulated regions, including the Moscow megacity region. This paper analyzes the chemical evolution of the atmosphere over the Moscow region during the 2010 heat wave by integrating available ground based and satellite measurements with results of meso-scale modeling. The state-of-the-art CHIMERE CTM is used, which is modified to take into account air pollutant emissions from wildfires and the shielding effect of smoke aerosols. The wild fire emissions are derived from satellite measurements of the fire radiative power and are optimized by assimilating data of ground measurements of carbon monoxide (CO) and particulate matter (PM10) into the model. It is demonstrated that the optimized simulations reproduce independent observations, which were withheld during the optimisation procedure, quite adequately (specifically, the correlation coefficient of daily time series of CO and PM10 exceeds 0.8) and that inclusion of the fire emissions into the model significantly improves its performance. The results of the analysis show that wildfires were a principal factor causing the observed air pollution episodes associated with the extremely high level of daily mean CO and PM10 concentrations (up to 10 mg m-3 and 700 μg m-3 in the averages over available monitoring sites, respectively) in the Moscow region, although accumulation of anthropogenic pollution was also favoured by a stagnant meteorological situation. In contrast, diagnostic model runs indicate that ozone concentrations could reach very high values even without fire emissions which provide "fuel" for ozone formation, but, at the same time, inhibit it as a result of absorption and scattering of solar radiation by smoke aerosols. The analysis of MOPITT CO measurements and of corresponding simulations indicates that the observed episodes of extreme air pollution in Moscow were only a part of a very strong perturbation of the atmospheric composition, caused by wildfires, over the largest part of European Russia. It is estimated that 2010 fires in the European part of Russia emitted ~9.7 Tg CO, that is more than 85% of the total annual anthropogenic CO emissions in this region. About 30% of total CO fire emissions in European Russia are identified as emissions from peat fires. © 2011 Author(s).

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Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Air Pollution, Temperature

Air Pollution: Particulate Matter, Other Air Pollution

Air Pollution (other): CO

Temperature: Extreme Heat

Geographic Feature: ☑

resource focuses on specific type of geography

Urban

Geographic Location: ☑

resource focuses on specific location

Non-United States

Non-United States: Europe

European Region/Country: European Country

Other European Country : Russia

Health Impact: ☑

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Mitigation/Adaptation: ☑

mitigation or adaptation strategy is a focus of resource

Mitigation

Model/Methodology: ☑

type of model used or methodology development is a focus of resource

Computing System, Exposure Change Prediction, Methodology

Resource Type: ☑

format or standard characteristic of resource

Multimedia

Timescale: ☑

time period studied

Time Scale Unspecified